Black-blood T2-weighted Spin-echo Echo Planar Imaging of the Liver with SENSE: A Optimization and Feasibility Study

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Purpose: To optimize and assess the feasibility of a faster sensitivity encoded (SENSE) black-blood T2-weighted spin-echo echo-planar imaging sequence (BB-EPI) for MR imaging of the liver.

Material and Methods: In this study, six volunteers and sixteen patients (mean age 54, range 23-80, 9 male and 7 female) were scanned (1.5T Philips Intera). In the volunteer study, BB-EPI was optimized by interactively changing parameters (interecho spacing (0.5-1.5 ms), diffusion-weighting (b=0, 20, 40, 50), echo time (TE=50, 60, 80), and resolution) with regard to distortion, suppression of the blood signal, and sensitivity to motion. The influence of each change was recorded. After satisfactory results, BB-EPI sequence was applied in patients (n=16) with the following abnormalities: cysts (multiple), hemangiomas (3), liver metastasis (3), liver adenoma (1), focal nodular hyperplasia (2), dysplastic nodule (1), hepatocellular carcinoma (2), hemochromatosis (1), and Budd-Chiari (1). The overall image quality (on a scale of 1-5), signal-to-noise ratio (SNR) of the liver, and contrast-to-noise ratio (CNR) for solid and non-solid lesions measured on BB-EPI were compared to our standard respiratory-gated fat-suppressed T2-weighted turbo spin-echo (TSE). Fisher's exact test was used to compare the means for significant differences ($p<.05$).

Results: BB-EPI was improved by the following steps: 1) less frequency encoding than phase points allowed a higher EPI factor and a decreased echo spacing; 2) SENSE factor 2 facilitated a further increase in the EPI factor that resulted in a decreased echo spacing with less distortion and chemical shift artifacts; 3) reversed polarity of the phase encoding gradient decreased the organ deformation; 4) a b-factor of 20 provided homogeneous black-blood imaging. In patients, the mean overall image quality score for BB-EPI (3.5±0.9) and TSE (3.6±0.5), and the SNR of the liver on BB-EPI (7.6±4.0) and FSE (8.9±4.6) were not significantly different ($p>.05$). The CNR of solid and non-solid lesions on BB-EPI, respectively 7.5±5.7 and 10.2±4.2, was not significantly different ($p=.579$). The CNR of solid and non-solid lesions on TSE, respectively 6.0±5.9 and 17.0±5.3, was significantly different ($p=.031$).

Conclusion: Four major steps were identified that improved the image quality for black-blood T2-weighted spin-echo echo planar imaging with SENSE. The optimized sequence settings proved to be feasible in patients with the overall image quality and signal-to-noise ratio of the liver comparable to our standard respiratory-triggered fat-suppressed T2-weighted turbo spin-echo sequence.